NOVEMBER, 1904 BULLETIN 224

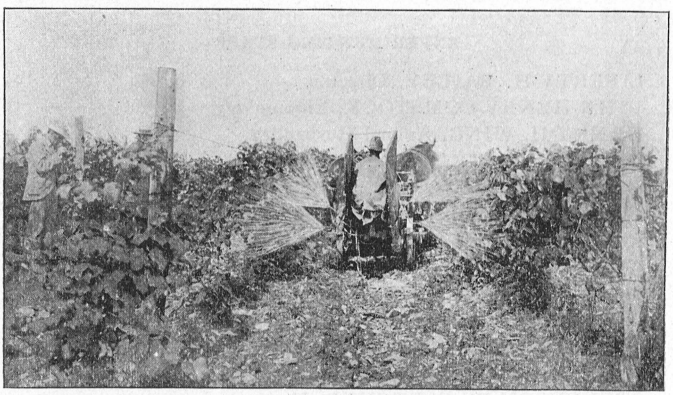
CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Entomology (Extension Work)

TWO GRAPE PESTS

I. EFFECTIVE SPRAYING FOR THE GRAPE ROOT-WORM

II. A NEW GRAPE ENEMY: THE GRAPE BLOSSOM-BUD GNAT



By M. V. SLINGERLAND and FRED JOHNSON

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

College of Agriculture, Cornell University, Nov. 21, 1904.

Hon. C. A. Wieting, Commissioner of Agriculture, Albany.

Sir:—About one hundred and fifty different kinds of insects have been recorded as feeding on the grape-vine in this country; but not more than one-tenth of these now rank as serious or first-class insect pests, and only about one-half of the latter (or about half a dozen in all) have thus far done much injury in New York vineyards. This Experiment Station has made extensive studies of practically all of the serious insect pests of the grape-vine in New York, the only exception being that of the Rose-chafer, and upon this pest one season's preliminary observations and experiments have already been made. The previous results have been published in the following bulletins:

Bulletin 104, 1895. Climbing Cutworms in Western New York.

Bulletin 157, 1898. The Grape-vine Flea-Beetle.

Bulletins 184 and 208, 1900 and 1902. The Grape Root-worm.

Bulletin 215, 1904. The Grape Leaf-hopper.

When we have completed the studies of the Rose-chafer, this Experiment Station will then have made investigations of all the insect pests that have thus far appeared in very destructive numbers in New York vineyards.

L. H. Bailey,
Director.

FIG. 26.—*A horse-power vineyard sprayer.*

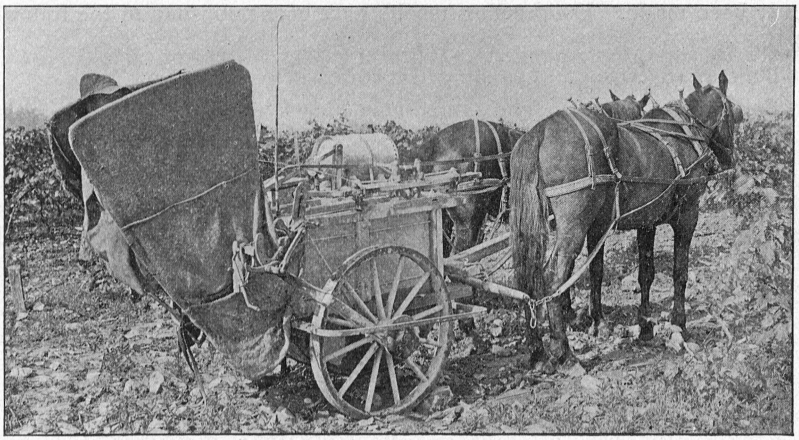


FIG. 27.—*A vineyard sprayer combining horse-power and compressed-air power. Note the effective, home-made screen to keep the spray from the driver.*

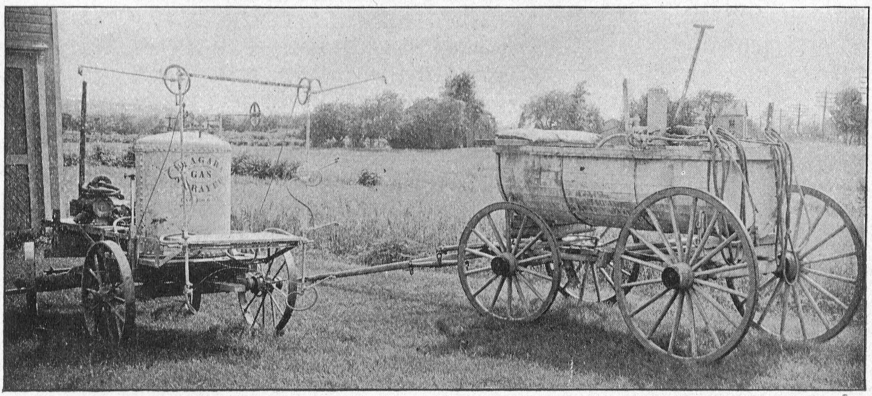


FIG. 28.—*A horizontal, hand-power outfit for vineyard spraying (on the right); and a vineyard sprayer using compressed carbonic-acid gas for power (on the left). Note how the nozzles are arranged for effective spraying on the gas-power machine.*

I. EFFECTIVE SPRAYING FOR THE GRAPE ROOT-WORM

Fidia viticida WALSH

The grape root-worm continues to be a serious factor in grape-growing in the famous Chautauqua grape belt, although its ravages were less noticeable and the vineyardists were usually not so much alarmed during the past year as in 1903. It is to be hoped that the insect's life-pendulum has begun its expected downward swing into obscurity as a pest, and there have been some indications to warrant such a hope in the infested region. Favorable growing conditions in 1904 have enabled many vineyards to make a very encouraging showing of vine and fruit in spite of the root-worm.

In 1903, this grape root-worm practically ruined some European varieties in a grapery at Glen Cove, Long Island. This isolated outbreak doubtless has no connection with the widespread Chautauqua infestation, but it is a hint that the insect is liable to become injurious at any time in other grape-growing sections of New York. The root-worm is the most destructive insect enemy of the grape in the State, and all vineyardists should acquaint themselves with its characteristic habits and work.

During the past three years this Station has carried on extensive field experiments in Chautauqua County against the grape root-worm. Our discovery of the first appearance of this serious enemy of the vine in New York was announced in 1900 in Bulletin No. 184, and the results of a year's observations and extensive experiments were given in Bulletin No. 208, issued in December, 1902.

As the root-worm beetles eat the foliage of the grape in considerable quantities and feed openly on the upper sides of the leaves for two weeks or more, theoretically, it should be an easy matter to feed them poison with a spray pump. In 1902, we made extensive experiments on about 15 acres of vineyards with an arsenate of lead spray, the details of which are given in Bulletin No. 208, pages 189–191. The abnormal rainy season then interfered so much with our experiments that it was impossible to draw any definite conclusions either way. Although discouraged, we were not convinced of the futility of a poison spray as an effective method of fighting this insect.

Experiments in 1903.—In 1903, Mr. John W. Spencer coöperated with us in making a further test of a poison spray for the beetles working on the leaves. As a criterion for determining the results of spraying, we counted the egg-clusters laid on the vines. As all of the eggs are always laid under the loose bark on the vines, their presence or absence is a much better

and surer test of the number of grubs that may later attack the vine than to dig around the roots and count the grubs one may chance to find in the soil. In July Mr. Spencer reported (*The Grape Belt*, July 24, 1903) the following results from spraying with arsenate of lead at the rate of 4 pounds in 50 gallons of water: *Plot No. 1* was not sprayed; the foliage was much eaten by the beetles; and 97 egg-clusters were found on 10 vines. *Plot No. 2* was sprayed once thoroughly about the time the beetles emerged from the soil; there was but little feeding on the leaves; and only 7 egg-clusters were found on 10 vines. *Plot No. 3* was sprayed thoroughly about the time the beetles emerged and again about eight days later; there were scarcely any of the characteristic "markings" of the beetles on the leaves; and only 1 egg-cluster was found on 10 vines. The egg-clusters on the sprayed vines averaged only about 15 eggs each, while those on the unsprayed vines averaged twice as many. This work was done in the most thorough and accurate manner by the junior author, Mr. Johnson. These striking results whereby more than 95 per cent of the eggs were apparently prevented from being laid, were certainly very encouraging. It should be said, however, that there were contrary opinions in regard to the efficacy of this spraying (Bulletin 72, N. Y. State Museum, p. 41. *Rural New-Yorker*, June 4, 1904, p. 449). However, another reliable vineyardist also sprayed a large part of his vines but once with the arsenate of lead, and he felt very sure that he accomplished much toward controlling this destructive pest; and a superficial examination of his vines in comparison with a neighbor's gave very encouraging results.*

These encouraging results led many of the vineyardists in the infested region to arrange to spray in 1904.

Experiments in 1904.—This Station also determined to get conclusive evidence, if possible, one way or the other in 1904. Fortunately, a large vineyard was placed at our disposal into which a swarm of the beetles had migrated and fed extensively from a badly infested vineyard across a meadow 30 or 40 rods away the preceding summer. This migration of the beetles in a body from one vineyard into another thrifty one affording better pasturage for themselves and their grubs later, is a new and very alarming fact. For it means that the best-cared-for vineyards are constantly menaced by neighboring infested vineyards where no fight is being made against the pest.

Many of the grubs were found on the roots of the vines in our experimental vineyard in the fall of 1903, and the next June fifteen pupæ were hoed out from beneath some vines. Thus the vineyard was well infested by the insect, and as the vines were very thrifty and in heavy foliage during the season, the conditions were ideal and seemed to meet the objections made against our previous year's work.

* Others who examined this vineyard for the grubs in October reported that "the good results were more apparent than real," but the owner, who was prevented by serious illness from showing the sprayed and unsprayed portions, tells us that the wrong vines were examined.

The first root-worm beetle was seen in the experimental vineyard on June 23, and spraying was begun two days later, or on nearly the same date as in 1903. Six rows of vines through the center were left unsprayed for a check experiment, and the remainder of the vineyard on one side the check rows was sprayed with arsenate of lead, and on the other side this poison was used with Bordeaux mixture. Four pounds of the poison was used in fifty gallons of water or Bordeaux mixture. The first spraying was finished on July 2, and on July 11 and 12 the vines were again sprayed with the same mixtures. The work was thoroughly done by the junior author, who is an expert in this kind of work. Part of the first spraying was done with a hand-power, horizontal pump on a large tank (Fig. 28), and the remainder of the work was done with a carbonic-acid gas sprayer (Fig. 28), which thoroughly sprayed in one day 7¼ acres. The total cost of the first spraying on 8¼ acres was $39.10 and 1500 gallons of poison were used. The second application cost only $23.15 to apply 1000 gallons of poison. This difference in cost was due to the more rapid but equally as thorough work with the carbonic-acid gas-power machine that required the services of but two men, one to drive and one to attend the fixed nozzles. The gas-power pump with its higher pressure gave a finer spray and thus used less of the poisonous mixture in the second spraying. With proper apparatus, vineyards can be sprayed thoroughly and effectively for the root-worm beetles at the rate of six to eight acres a day for not over $3 an acre for each application.

Results of spraying experiments in 1904.—Soon after the second application of poison on the experimental vineyard, it was very evident that the foliage on the sprayed vines was being much less eaten by the beetles than on the check rows. On July 21, the junior author applied our decisive test by counting the egg masses on 15 vines in the sprayed sections each side of the check rows, and then on 15 unsprayed vines, with the following results:

151 egg-clusters were found on 15 unsprayed vines.

11 egg-clusters were found on 15 vines sprayed twice with arsenate of lead.

7 egg-clusters were found on 15 vines sprayed twice with the poison in Bordeaux mixture.

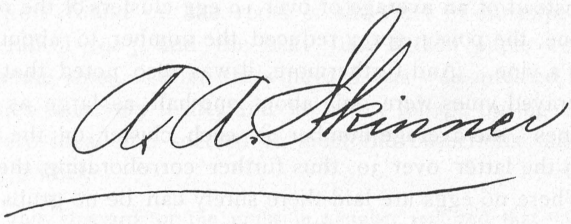
These results are equally as striking as those we obtained in 1903. Instead of an average of over 10 egg-clusters of the root-worm beetles on each vine, the poison spray reduced the number to about one-half an egg cluster to a vine. And furthermore, it was also noted that the egg-clusters on the sprayed vines were only about one-half as large as those on the untreated vines; the average number in each cluster on the former was about 15 and on the latter over 30, thus further corroborating the previous season's work. Where no eggs are laid there surely can be no grubs to eat the roots and kill the vines. It is rarely that such remarkably favorable results are obtained with insecticides in experiments against any injurious insect. We believe *our*

results are decisive and conclusive, and we consider it demonstrated that the grape root-worm can be effectively fought and controlled with a poison spray.

In all of our experiments against the root-worm, we have used the arsenate of lead or "Disparene" poison, because it sticks well and can be used much stronger than the other poisons without danger of injuring the vines. However, it is probable that very effective work can be done against the beetles with Paris green (1 lb. in 50 gals.) or arsenite of soda or lime (1 lb. of the white arsenic in 100 gals.) when used with Bordeaux mixture; if used alone in water these poisons might burn the foliage severely. We recommend the use of four pounds of the arsenate of lead or "Disparene" in 50 gallons of water or Bordeaux mixture. Make two very thorough applications of this poison, the first as soon as the first beetles are seen in the vineyard, or about June 20 to 25, and the second a week or ten days later. These applications will reach the grape berry-moth (as described in Bulletin 223), and if Bordeaux mixture is used, the fungous diseases also will be checked. For the root-worm beetles the spray should be aimed at the upper surfaces of the leaves, for there is where the beetles feed, and the more thoroughly every leaf is covered with a fog-like spray of poison, the more effective it will be. *We doubt if the grape root-worm can be so cheaply and effectively fought and controlled by any other method.*

In further confirmation of the above conclusions, it is a pleasure to quote the following from a letter received last August from a prominent vineyardist in the infested region:

"You cannot doubt my great gratification in reporting a decisive and complete victory as the result of this year's fight against the root-worm. I sprayed the larger part of my vineyards twice with 'Disparene,' and where this was done a critical examination revealed scarcely any eggs and the foliage is almost wholly free from the marks of the beetles; while in unsprayed vineyards nearby, eggs were very abundant, the foliage is badly marked, and all the indications of a serious infestation are present. From such results there can be but one conclusion, namely, that timely and thorough spraying with 'Disparene' or arsenate of lead affords absolute protection to vineyards from the grape root-worm and restores the grape industry to its former position as a safe and profitable business."



Does the spray kill the root-worm beetles? We think it does kill many of them, and it may also act as a preventive. In a day or two after the poison had been applied, we found quite a number of dead beetles on the ground beneath the vines, and some were seen to drop to the ground and die. As the beetles are small and resemble a bit of soil, and as ants soon find and destroy them, it is not an easy matter to find the dead ones on the ground. A few of these were submitted to our chemist to test for arsenic but none was found, indicating that they may not have been poisoned.* It is not improbable that some of the beetles may shun the poisoned foliage and go to more attractive unsprayed vineyards. But it matters little to the vineyardist whether the beetles are killed or driven away, so long as they are prevented from laying eggs on his vines and a crop of destructive grubs thus prevented from eating the roots.

Notes on other methods.—Great claims were made in 1903 for the effectiveness and practicability of various devices for catching the root-worm beetles when they were jarred from the vines. Several vineyardists bought Morehouse "beetle-catchers" and planned to use them in 1904. Some did use them for a while but soon discarded them for the poison spray. A prominent vineyardist who invested $45 in one of these machines gives us the following report of his experience: "My experience with the beetle-catcher was rather disappointing. The jarring of the vines took off some of the fruit, and the machine did harm to the vines by tearing off some of the canes and coming in forcible collision with the trunks, even when the latter were straight. Though I think a lighter machine might do less harm and be more successful, I shall rely hereafter wholly upon spraying."

By June 20, most of the root-worms were found to have transformed to the tender pupa or "turtle" stage in our experimental vineyard and horse-hoeing was begun at once. But we were surprised to find that very few pupæ were turned out either by the horse-hoe or by hand-hoeing to the usual depth of cultivation. On working deeper, however, may pupæ were found. A possible explanation may be that the unusually severe winter conditions drove the grubs more deeply into the soil. Under normal conditions, we still believe that much can be done to check this insect by thorough cultivation during the last ten days of June, when it is in the tender pupa stage.

NOTES ON PRACTICAL VINEYARD SPRAYING

Sooner or later, in all grape-growing sections the time comes when insect pests or fungous diseases invade the vineyards and the crop is ruined unless a vigorous warfare is carried on against such enemies. A good spray pump is

* Several of these dead beetles were kept in a tightly corked bottle for ten days when a lot of small maggots crawled out of them. Thinking that these maggots might be parasitic enemies of the root-worm beetles, we put some soil in the bottle and in this the maggots transformed into a small fly known as *Aphiochaeta fungicola* Coq. This fly was first bred from a tree fungus (Can. Ent. XXVII, p. 105). It is doubtless a carrion-feeder and thus works only on the dead root-worm beetles.

the most useful and effective implement in this warfare. For many years the famous Chautauqua vineyards were practically free from fungous and insect troubles, and no spray pumps were needed. But during the past few years such insect foes as root-worms, leaf-hoppers, berry-moths and flee-beetles have ravaged many of the vineyards, and now rot, mildew, and anthracuose fungi are on the increase. The time has come when every vineyardist should be prepared to spray a deadly dose into the menu of these serious menaces to his business.

The fungous rots and mildews usually succumb to a thorough and timely application of Bordeaux mixture, as many vineyardists can testify. And this Station has demonstrated that the root-worm beetles (in this Bulletin), the berry-moths (Bulletin No. 223) and flea-beetles (Bulletin 157) can be controlled with a poison spray ; and we conquered the leaf-hoppers with a whale-oil soap spray (Bulletin No. 215). Therefore, a vineyardist's ammunition should consist primarily of Bordeaux mixture and some poison, preferably arsenate of lead or " Disparene "; to this add whale-oil soap for leaf-hopper emergencies. Anyone can easily make this ammunition and the ingredients are cheap and readily obtained. Our Spray Calendar Bulletin No. 217 gives detailed information for preparing the mixtures.

During the past season several vineyardists used a ground or " New Process " lime in making Bordeaux mixture. Two samples of these prepared limes were submitted to our chemist, who reports that both were made from dolomitic limestone, and one contained over 35 per cent and the other over 48 per cent of magnesia and other matter that were non-available or practically useless for combining with the copper sulphate in making Bordeaux mixture. It is undoubtedly easier and handier to use these " New Process" limes than the common stone lime, but it requires from one-third to one-half more of them to satisfy the chemical combinations required in making good Bordeaux mixture. Unless the ferro-cyanide test is used in making the Bordeaux mixture, there is danger of not getting in enough of the kind of lime necessary to neutralize the copper sulphate and burning of the foliage may result. Thus it is doubtful if it pays in the end to load up the spray mixture with so much useless powder.

After getting his ammunition ready, the vineyardist is confronted with the more serious and difficult problem of its proper, effective and practical application. For the cheapest and most practical spraying of large vineyards, it is necessary to have a pump run by some stronger and cheaper power than hand power, and there should be a suitable arrangement of several adjustable nozzles. When the gun is properly loaded, one or two persons should be able to drive it between the rows of vines and fire a continuous volley of effective and well-directed shots on each side at the enemies as fast as the horses walk. Some of the spraying rigs used in the Chautauqua vineyards last season are shown in Figs. 26, 27 and 28. The best arrangement of nozzles we

have seen for thorough spraying in vineyards is on the gas-power pump in Fig. 28. For the most effective work it needs three or four nozzles on each side, and for the root-worm beetles one of them should spray downward onto the top of the vines. Have the nozzle connections adjustable so they may be easily arranged to suit vines of different ages and heights.

A very fine, misty or fog-like and forceful spray is necessary for the most effective work, and to obtain and continue this through six or eight nozzles, it is necessary to have a continuous pressure of from 80 to 100 pounds. All spray pumps should have a pressure gauge attached. It is too laborious and expensive to maintain this pressure by hand-power in large vineyards. But it can be done cheaply and practicably by horse-power aided by compressed air, by compressed air alone, by compressed carbonic-acid gas, and by steam or gas engines. There are now various types of such power spraying machines on the market, but they need further adapting and strengthening for vineyard work. Horse-power alone does not seem to work up sufficient continuous pressure for six or eight nozzles. Perhaps the cheapest and most available way of obtaining a satisfactory pressure is by attaching to a horse power machine an air-tank in which air is being continuously compressed as the horses move. A strong and durable machine, thus combining horse-power and compressed air, which will supply a continuous pressure of 80 to 100 pounds to six or eight fixed nozzles properly arranged would enable vineyardists to effectively fight their insect and fungous enemies at a minimum of expense for power.

The apparatus for using compressed air, or steam, or gasoline power is rather expensive, but with good pumps and properly arranged nozzles, very effective and satisfactory work can be done cheaply and quickly. The tanks of compressed carbonic-acid gas afford a neat, compact and very efficient power, but they are somewhat expensive and obtainable only in large cities.

II. A NEW GRAPE ENEMY: THE GRAPE BLOSSOM-BUD GNAT

FAMILY *Cecidomyiidae*

Vineyardists often find after blossoming time that there has been a poor "setting of the fruit" on many of the grape clusters, and the clusters present a ragged appearance throughout the season. Usually this is attributed to unfavorable weather conditions, either frost or rains, which kill the blossoms or prevent proper fertilization. Doubtless these causes are often responsible for the ragged clusters of fruit, but we have discovered another cause which sometimes may have more to do with it than weather conditions.

The discovery.—On June 12, 1904, when the blossom-buds of the grape clusters were about two-thirds developed in a Westfield vineyard, the attention of the junior author was attracted by some of the buds that were about twice as large as the normal ones, and of a yellowish or dark reddish color, with a watery and swollen appearance. An examination of these abnormal buds showed that they were inhabited by many minute maggots, sometimes as many

as eighteen were found in a single grape blossom-bud, as shown in the enlarged pictures of opened buds in Fig. 29. It seems almost incredible that so many maggots could find sustenance in such a small home. Infested and normal blossom-buds are shown enlarged in Fig. 29. The maggots seemed to feed mostly on the pistil of the developing blossom, causing an unusual development or gall-like growth of the rest of the blossom-bud.

The nature of this new grape enemy.—We have never seen, and have little hope of soon breeding, the adult insect which laid the eggs from which these blossom-bud maggots hatched. The little maggot shown in the lower part of Fig. 29, measures from 2.2 to 2.4 mm., or about 1–16 of an inch in length, and is of a whitish color while in the buds, but changes to a light lemon-yellow when it is ready to transform. This is the only stage of the insect we have seen, but the fact that these maggots possess a minute, forked organ, called by entomologist a "breast-bone" (visible near one end of the maggot in Fig. 29), indicates that the adult is one of the little two-winged flies known as "gall-gnats." Among its nearest insect relatives are the clover-seed midge, the Hessian-fly, and the wheat midge, all serious pests of field crops. When the minute grape blossom-bud gnat is found, as it is doubtless a new species, we would suggest it be given the specific name of *johnsoni* in honor of the junior author who first observed its work. The flies should be sought for during the latter part of May on the clusters of blossom-buds in vineyards.

We have searched the literature, both American and European, and find no record or description of such an insect working in grape blossom-buds; and there is nothing about it in the records of the Bureau of Entomology at Washington, reports Dr. Howard. Several of these gall-gnats live in galls in grape leaves in America and Europe, and one has been found in the grape-berries in Europe. We seem to have discovered, not only a new grape enemy, but a species of insect hitherto unknown.

Its distribution and destructiveness.—This new grape enemy was found last June in nearly every vineyard examined in the towns of Ripley, Westfield, Portland and Brocton in Chautauqua County. It was always more abundant in neglected vineyards and those near wood-lots or hedge-rows. We suspect that the insect is not uncommon in many of the other grape-growing regions of the country.

Many of the clusters in infested vineyards contained a dozen or more of the abnormal blossom-buds, and in one vineyard nearly a third of the buds were destroyed on many clusters. Thus the insect is capable of making very ragged bunches of grapes, for all infested blossom-buds soon appear blackened and blasted and fall from the clusters.

The life-history and habits of the insect.—We have but little definite knowledge of the life-history of this grape blossom-bud gnat. Probably the minute, two-winged gnats emerge from the soil in May and lay their eggs on, or possibly stick them into, the growing blossom-buds of the grape clusters.

Hatching in a few days, the little maggots live inside the blossom-buds, feeding on the pistil and causing the bud to enlarge and take on a reddish color. Developing rapidly, the maggots get full grown and are ready to leave before the blossoms open. They emerge from the buds either by eating holes in the sides, or throught slits caused by the breaking of the bud-cap in an attempt to open into the blossom. Dropping to the ground, the maggots soon bury themselves. We have found as many as eighteen maggots in a single grape blossom-bud. None of the infested buds ever open into blossoms, but soon shrivel and blacken or "blast" and drop off after the maggots leave them. The maggots wriggle about actively, and often bring the two ends of their body together, and by suddenly straightening out, throw themselves nearly half an inch into the air and about that distance over the ground.

By June 23, all the maggots had gone into the ground and their further life-story is still one of Nature's many mysteries. Possibly they may transform into another brood of the gnats whose maggots make galls on the grape foliage or live on some different plant; or the insect may remain in the soil as maggots or pupæ until the next May. We saw nothing more of the insect after the maggots went into the soil late in June, and were unable to keep the maggots alive in our cages.

Remedial suggestions.—Apparently there is no practicable way to get at this new grape enemy with a spray of any kind. It is out of reach inside the little blossom-buds. But the fact that we found it occurring in injurious numbers only in neglected vineyards or near wood-lots or hedges, indicates that the progressive grape-grower who properly cultivates and feeds his vines can always keep this new insect under control.

MARK VERNON SLINGERLAND
FRED JOHNSON

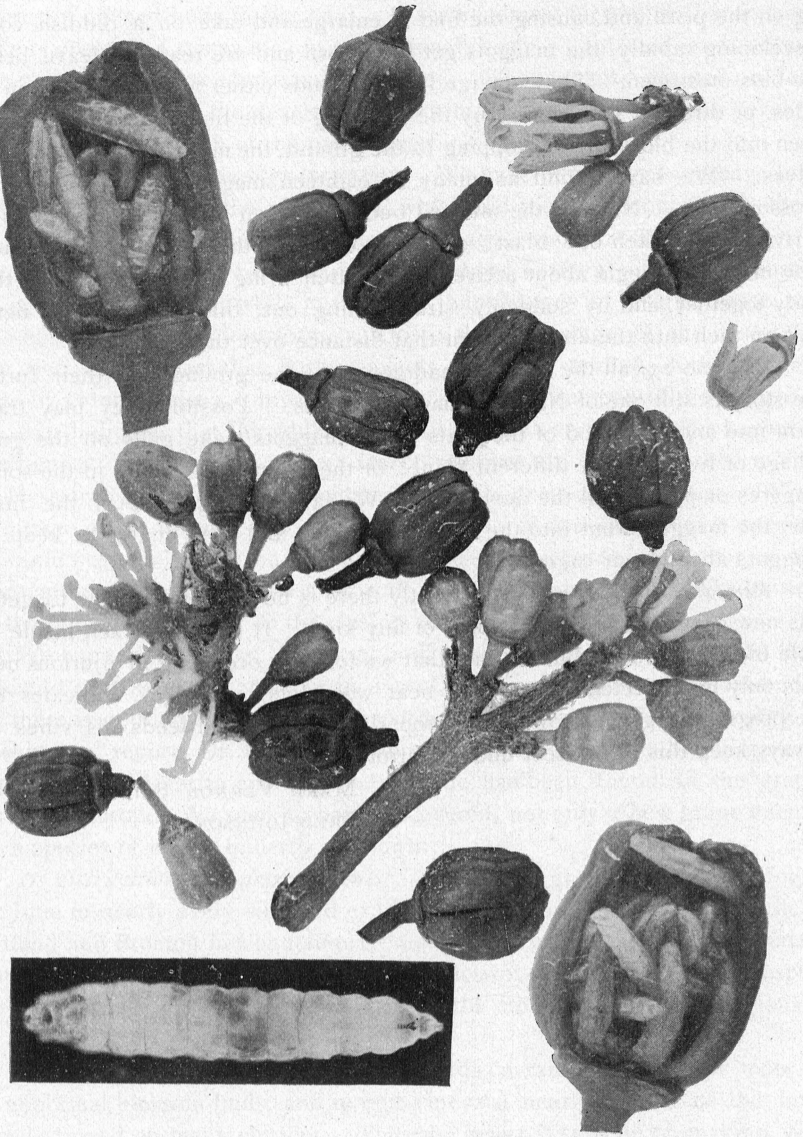


FIG. 29.—*The grape blossom-bud gnat and its work (enlarged). Compare the normal blossom-buds with the larger and darker buds. Two infested buds are more enlarged and opened to show the maggots at work. One of the maggots is shown much enlarged in lower part of the figure.*

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